EOD HEAD-END ACCESS ARCHITECTURE

Application No.: 10/725,092 Inventor: RAKIB, et al. Docket No.: TER-045
Title: CABLE MODEM TERMINATION SYSTEM WITH FLEXIBLE ADDITION OF SINGLE UPSTREAMS

OR DOWNSTREAMS

1/17

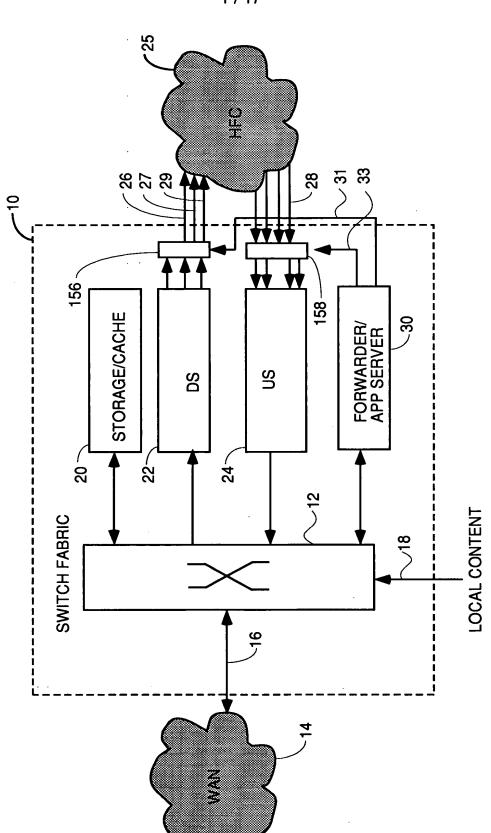
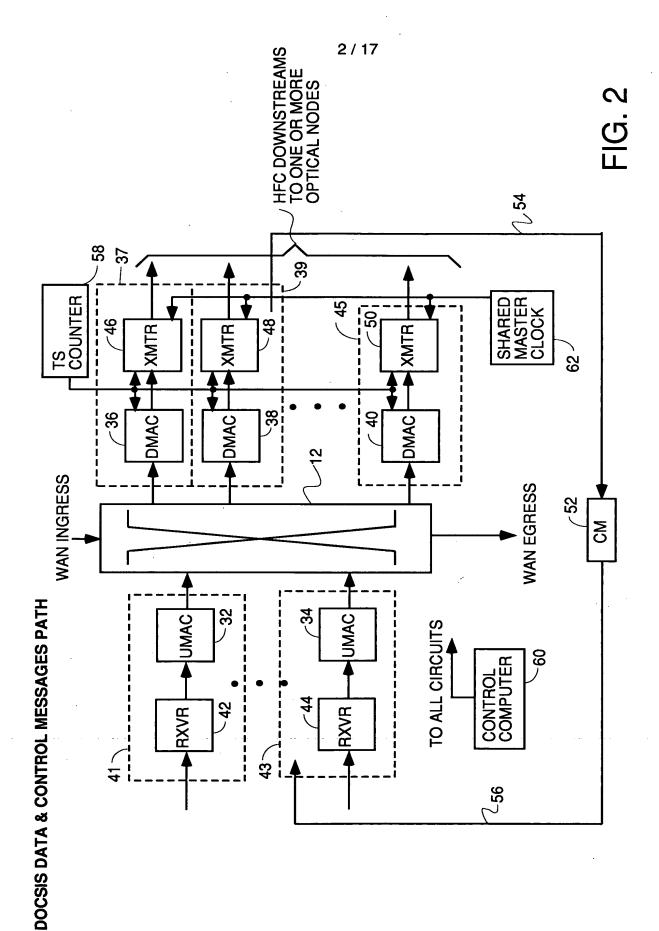
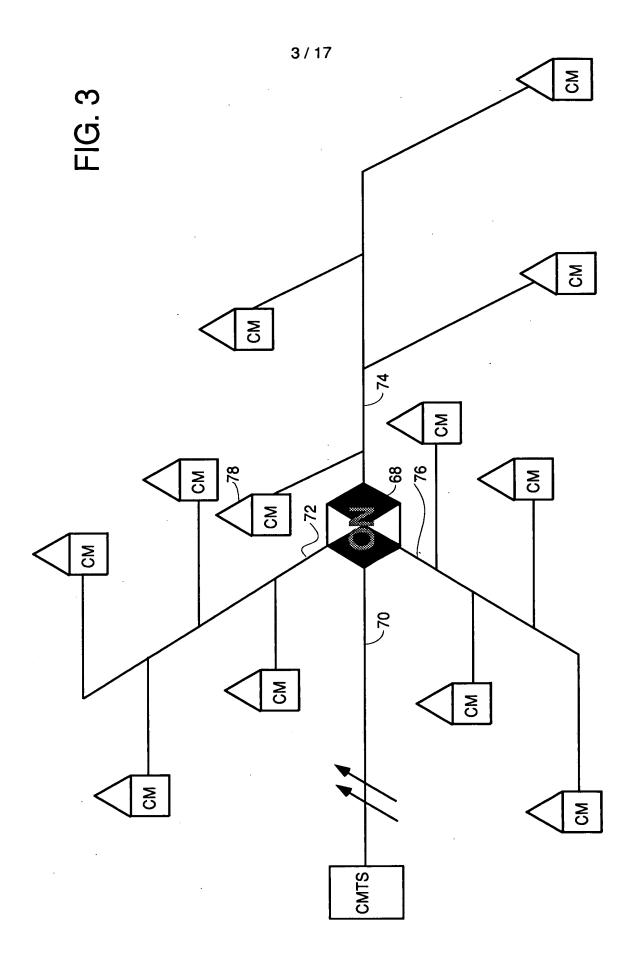


FIG. 1

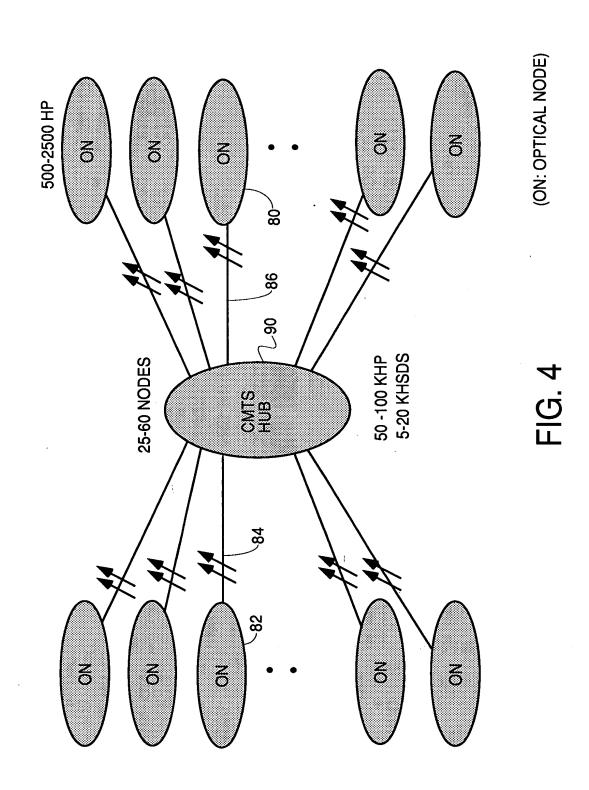
Title: CABLE MODEM TERMINATION SYSTEM WITH FLEXIBLE ADDITION OF SINGLE UPSTREAMS



Title: CABLE MODEM TERMINATION SYSTEM WITH FLEXIBLE ADDITION OF SINGLE UPSTREAMS



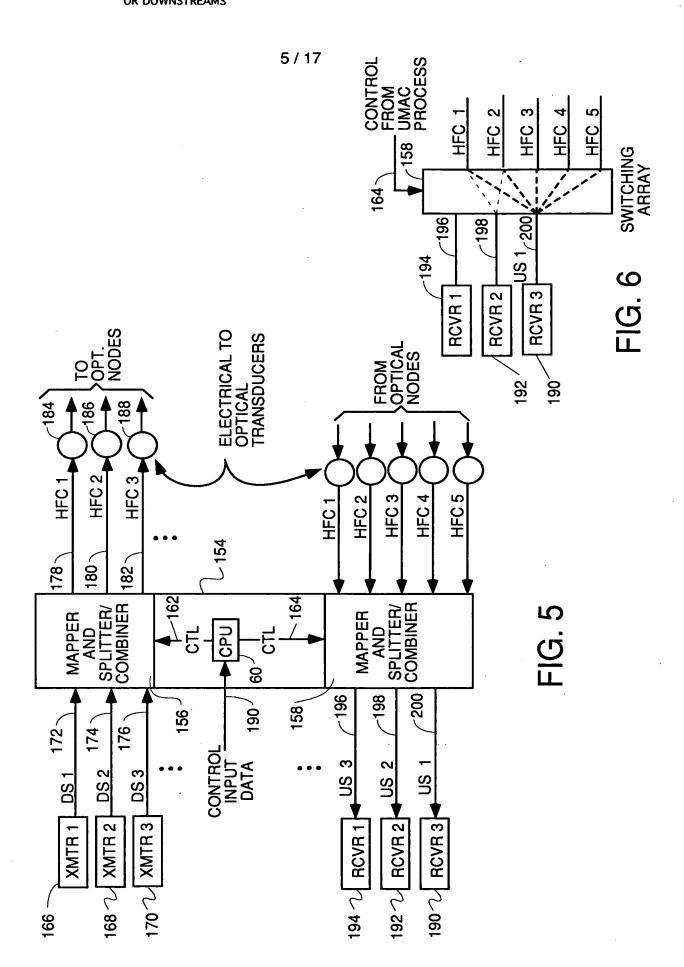
4 / 17

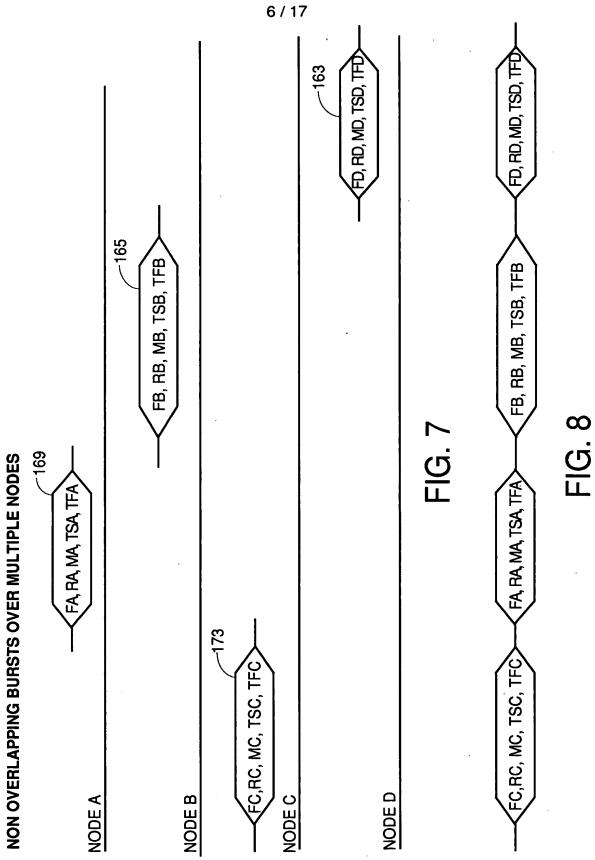


HFC NETWORK - STAR TOPOLOGY

1

Title: CABLE MODEM TERMINATION SYSTEM WITH FLEXIBLE ADDITION OF SINGLE UPSTREAMS OR DOWNSTREAMS





OR DOWNSTREAMS

7/17

PROCESS TO CREATE AND CHANGE US/DS MAPPING IN THE PRESENCE OF NOISE AGGREGATION

CMTS DETERMINES DOWNSTREAMS
NEEDED FOR CMs IN SYSTEM

- 222

CMTs DOWNSTREAM TRANSMITTERS FOR DOWNSTREAMS THAT ARE TO SHARE AN UPSTREAM SYNCHRONIZE THEIR TIMESTAMP COUNTERS TO THE SAME CMTs MASTER CLOCK AND DOWNSTREAM TRANSMITTERS THAT ARE TO SHARE AN UPSTREAM SYNCHRONIZE THEIR SYMBOL CLOCKS TO THE CMTs MASTER SYMBOL CLOCK FOR THE SHARED UPSTREAM. MAP DOWNSTREAMS TO PARTICULAR OPTICAL NODES AND GENERATE DOWNSTREAM MAPPER SWITCH CONTROL SIGNALS TO IMPLEMENT THIS INITIAL DOWNSTREAM MAPPING. START TRANSMITTING DOCSIS DOWNSTREAMS OF ONE OR MORE TYPES ON EACH OPTICAL NODE

- 224

DMAC PROCESSES FOR DOWNSTREAMS SHARING AN UPSTREAM SEND DOWNSTREAM SYNC MESSAGES WITH TIMESTAMP SAMPLES THEREIN

226

UMAC DECIDES WHICH DOWNSTREAMS ARE TO SHARE AN UPSTREAM, AND CONTROLS SWITCH 12 TO SEND DATA DEFINING SHARED UPSTREAM CHANNEL PARAMETERS AND BURST PROFILE FOR THE SHARED UPSTREAM TO DMAC PROCESS FOR EACH DOWNSTREAM WHICH IS TO SHARE THE UPSTREAM. UMAC FOR SHARED UPSTREAM OR SOME OTHER CONTROL COMPUTER THEN GENERATES SUITABLE CONTROL SIGNALS TO CONTROL UPSTREAM MAPPER TO COUPLE THE UPSTREAM SIGNAL PATHS FROM OPTICAL NODES WHICH RECEIVE DOWNSTREAMS SHARING THE UPSTREAM TO THE RF INPUT OF THE SHARED UPSTREAM RECEIVER TO IMPLEMENT THE INITIAL UPSTREAM MAPPING

228

DMAC PROCESSES USE DATA RECEIVED FROM UMAC PROCESS FOR SHARED UPSTREAM TO GENERATE AND TRANSMIT UCD MESSAGE DEFINING THE CHANNEL CHARACTERISTICS AND BURST PROFILE OF SHARED UPSTREAM

- 230

UMAC PROCESS FOR THE SHARED UPSTREAM DETERMINES INITIAL RANGING CONTENTION INTERVALS AND TRANSMITS MAP DATA TO APPROPRIATE DMAC PROCESSES OF DOWNSTREAMS THAT WILL SHARE THE UPSTREAM (THE DMAC GROUP)

OR DOWNSTREAMS

8/17

FROM FIG. 9A

- 232

DMAC GROUP PROCESSES DATA DEFINING INITIAL RANGING CONTENTION INTERVAL INTO MAP MESSAGES AND SEND MAP MESSAGES ON ALL DOWNSTREAMS THAT SHARE THE UPSTREAM

- 234

UMAC OF SHARED UPSTREAM AND SHARED RECEIVER RECEIVES UPSTREAM RANGING BURSTS FROM CMS TUNED TO DOWNSTREAMS IN THE DOWNSTREAM GROUP AND PROCESSES THEM IN CONVENTIONAL DOCSIS RANGING TO MAKE OFFSET MEASUREMENTS AND DEVELOP UPSTREAM EQUALIZATION COEFFICIENTS AND SENDS RANGING RESPONSE MESSAGE TO EACH CM FROM WHICH A RANGING BURST WAS SUCCESSFULLY RECEIVED.

236

UMAC OF SHARED UPSTREAM DOES DISCOVERY OF WHICH CMs ARE TUNED TO THE DOWNSTREAMS IN THE DOWNSTREAM GROUP USING THE DOWNSTREAM IDS AND SIDS AND/OR MAC ADDRESSES IN THE INITIAL RANGING BURSTS. UMAC BUILDS A ROUTING TABLE FROM THIS INFORMATION.

238

UMAC OF SHARED UPSTREAM DETERMINES WHICH CMs STILL NEED TO SEND MORE RANGING BURSTS TO ACHIEVE INITIAL SYNCHRONIZATION AND GENERATES MAP DATA SETTING A PERIODIC STATION MAINTENANCE INTERVAL FOR EACH SAID CM. MAP DATA IS SENT TO DMAC PROCESSES FOR THE DOWNSTREAMS TO WHICH THESE CMs ARE TUNED.

240

CONVENTIONAL DOCSIS RANGING PROCESS IS COMPLETED USING INVITED RANGING BURSTS AND CMs REGISTER WITH CMTS.

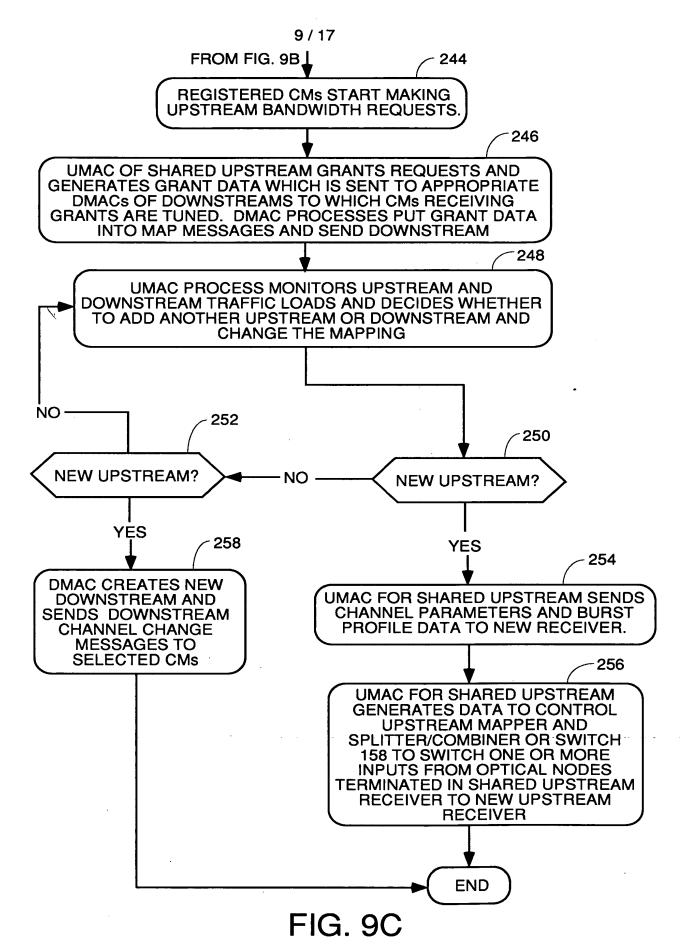
242

OPTIONAL ALTERNATIVE EMBODIMENT: UMAC PROCESS MONITORS SIGNAL-TO-NOISE RATIO, RECEIVED SIGNAL POWER, BIT ERROR RATE, BYTE ERROR RATE, PACKET LOSS RATE, AND IF UNACCEPTABLE, CREATES A NEW LOWER THROUGHPUT UPSTREAM AND ASSIGNS CMs THAT ARE HAVING PROBLEMS TO THAT NEW UPSTREAM.

TO FIG. 9C

FIG. 9B

Title: CABLE MODEM TERMINATION SYSTEM WITH FLEXIBLE ADDITION OF SINGLE UPSTREAMS



Title: CABLE MODEM TERMINATION SYSTEM WITH FLEXIBLE ADDITION OF SINGLE UPSTREAMS OR DOWNSTREAMS

10/17

PROCESS TO CREATE AND CHANGE US/DS MAPPING IN THE PRESENCE OF NOISE AGGREGATION

CMTS DETERMINES DOWNSTREAMS NEEDED FOR CMs IN SYSTEM 220

222

224

226

228

- 230

CMTS DOWNSTREAM TRANSMITTERS FOR DOWNSTREAMS THAT ARE TO SHARE AN UPSTREAM SYNCHRONIZE THEIR TIMESTAMP COUNTERS TO THE SAME CMTS MASTER CLOCK AND DOWNSTREAM TRANSMITTERS THAT ARE TO SHARE AN UPSTREAM SYNCHRONIZE THEIR SYMBOL CLOCKS TO THE CMTS MASTER SYMBOL CLOCK FOR THE SHARED UPSTREAM. MAP DOWNSTREAMS TO PARTICULAR OPTICAL NODES AND GENERATE DOWNSTREAM MAPPER SWITCH CONTROL SIGNALS TO IMPLEMENT THIS INITIAL DOWNSTREAM MAPPING. START TRANSMITTING DOCSIS DOWNSTREAMS OF ONE OR MORE TYPES ON EACH OPTICAL NODE

DMAC PROCESSES FOR DOWNSTREAMS SHARING AN UPSTREAM SEND DOWNSTREAM SYNC MESSAGES WITH TIMESTAMP SAMPLES THEREIN

UMAC DECIDES WHICH DOWNSTREAMS ARE TO SHARE AN UPSTREAM, AND CONTROLS SWITCH 12 TO SEND DATA DEFINING SHARED UPSTREAM CHANNEL PARAMETERS AND BURST PROFILE FOR THE SHARED UPSTREAM TO DMAC PROCESS FOR EACH DOWNSTREAM WHICH IS TO SHARE THE UPSTREAM. UMAC FOR SHARED UPSTREAM OR SOME OTHER CONTROL COMPUTER THEN GENERATES SUITABLE CONTROL SIGNALS TO CONTROL UPSTREAM MAPPER TO COUPLE THE UPSTREAM SIGNAL PATHS FROM OPTICAL NODES WHICH RECEIVE DOWNSTREAMS SHARING THE UPSTREAM TO THE RF INPUT OF THE SHARED UPSTREAM RECEIVER TO IMPLEMENT THE INITIAL UPSTREAM MAPPING

DMAC PROCESSES USE DATA RECEIVED FROM UMAC PROCESS FOR SHARED UPSTREAM TO GENERATE AND TRANSMIT UCD MESSAGE DEFINING THE CHANNEL CHARACTERISTICS AND BURST PROFILE OF SHARED UPSTREAM

UMAC PROCESS FOR THE SHARED UPSTREAM DETERMINES INITIAL RANGING CONTENTION INTERVALS AND TRANSMITS MAP DATA TO APPROPRIATE DMAC PROCESSES OF DOWNSTREAMS THAT WILL SHARE THE UPSTREAM (THE DMAC GROUP)

TO FIG. 10B **F**[6

FIG. 10A

OR DOWNSTREAMS 11/17 FROM FIG. 10A - 232 DMAC GROUP PROCESSES DATA DEFINING INITIAL RANGING CONTENTION INTERVAL INTO MAP MESSAGES AND SEND MAP MESSAGES ON ALL DOWNSTREAMS THAT SHARE THE UPSTREAM 234 UMAC OF SHARED UPSTREAM AND SHARED RECEIVER RECEIVES UPSTREAM RANGING BURSTS FROM CMs TUNED TO DOWNSTREAMS IN THE DOWNSTREAM GROUP AND PROCESSES THEM IN CONVENTIONAL DOCSIS RANGING TO MAKE OFFSET MEASUREMENTS AND DEVELOP UPSTREAM EQUALIZATION COEFFICIENTS AND SENDS RANGING RESPONSE MESSAGE TO EACH CM FROM WHICH A RANGING BURST WAS SUCCESSFULLY RECEIVED. 236 UMAC OF SHARED UPSTREAM DOES DISCOVERY OF WHICH CMs ARE TUNED TO THE DOWNSTREAMS IN THE DOWNSTREAM GROUP USING THE DOWNSTREAM IDs AND SIDs AND/OR MAC ADDRESSES IN THE INITIAL RANGING BURSTS. UMAC BUILDS A ROUTING TABLE FROM THIS INFORMATION. 238 UMAC OF SHARED UPSTREAM DETERMINES WHICH CMs STILL NEED TO SEND MORE RANGING BURSTS TO ACHIEVE INITIAL SYNCHRONIZATION AND GENERATES MAP DATA SETTING A PERIODIC STATION MAINTENANCE INTERVAL FOR EACH SAID CM. MAP DATA IS SENT TO DMAC PROCESSES FOR THE DOWNSTREAMS TO WHICH THESE CMs ARE TUNED. -240 CONVENTIONAL DOCSIS RANGING PROCESS IS COMPLETED USING INVITED RANGING BURSTS AND CMs REGISTER WITH CMTS. 242 UMAC PROCESS MONITORS SIGNAL-TO-NOISE RATIO RECEIVED SIGNAL POWER, BIT ERROR RATE, BYTE ERROR RATE, PACKET LOSS RATE, AND IF UNACCEPTABLE CREATES A NEW LOWER THROUGHPUT UPSTREAM AND ASSIGNS CMs THAT ARE HAVING PROBLEMS OR ARE OVER PERFORMING TO THAT NEW UPSTREAM.

Inventor: RAKIB, et al.

CABLE MODEM TERMINATION SYSTEM WITH FLEXIBLE ADDITION OF SINGLE UPSTREAMS

Docket No.: TER-045

Application No.: 10/725,092

Title:

FIG. 10B

12/17 FROM - 244 FIG. 10B REGISTERED CMs START MAKING UPSTREAM BANDWIDTH REQUESTS 246 UMAC OF SHARED UPSTREAM GRANTS REQUESTS AND GENERATES GRANT DATA WHICH IS SENT TO APPROPRIATE DMACs OF DOWNSTREAMS TO WHICH CMs RECEIVING GRANTS ARE TUNED. DMAC PROCESSES PUT GRANT DATA INTO MAP MESSAGES AND SEND DOWNSTREAM UMAC PROCESS MONITORS UPSTREAM AND DOWNSTREAM TRAFFIC LOADS AND DECIDES WHETHER TO ADD ANOTHER UPSTREAM OR DOWNSTREAM AND CHANGE THE MAPPING NO 252 250 **NEW UPSTREAM?** NEW DOWNSTREAM? NO - 260 UMAC FOR SHARED UPSTREAM YES **GENERATES DATA TO DEFINE** CHANNEL AND BURST PARAMETERS OF A NEW 258 UPSTREAM ID AND SENDS IT TO THE DMACs IN THE DOWNSTREAM GROUP DMAC CREATES A NEW DOWNSTREAM AND SENDS 262 DOWNSTREAM CHANNEL CHANGE MESSAGES TO CMs DMACs USE DATA TO GENERATE TO BE SWITCHED TO THE NEW NEW UCD MESSAGES THAT DOWNSTREAM, AND GENERATE DEFINE THE NEW UPSTREAM NEW DOWNSTREAM MAPPER AND SEND NEW UCD MESSAGES SWITCH CONTROL COMMANDS DOWNSTREAM TO CHANGE MAPPING OF TRANSMITTER OUTPUTS TO 264 OPTICAL NODES SEND UPSTREAM CHANNEL 266 CHANGE MESSAGES TO CMs THAT ARE TO BE CHANGED RE-INTIALIZE CMs ON TO THE NEW UPSTREAM **NEW UPSTREAM OR** CHANNEL, AND GENERATE NEW DOWNSTREAM PER **NEW UPSTREAM MAPPING** STANDARD DOCSIS SWITCH CONTROL COMMANDS **PROCESSING** IF NECESSARY TO CHANGE UPSTREAM MAPPING OF OPTICAL NODES TO RECEIVER INPUTS **FIG. 10C**

Title: CABLE MODEM TERMINATION SYSTEM WITH FLEXIBLE ADDITION OF SINGLE UPSTREAMS

OR DOWNSTREAMS

13 / 17

PROCESS TO CREATE AND CHANGE US/DS MAPPING WITHOUT NOISE AGGREGATION /220

CMTS DETERMINES DOWNSTREAMS
NEEDED FOR CMs IN SYSTEM

222

CMTS DOWNSTREAM TRANSMITTERS FOR DOWNSTREAMS THAT ARE TO SHARE AN UPSTREAM SYNCHRONIZE THEIR TIMESTAMP COUNTERS TO THE SAME CMTS MASTER CLOCK AND DOWNSTREAM TRANSMITTERS THAT ARE TO SHARE AN UPSTREAM SYNCHRONIZE THEIR SYMBOL CLOCKS TO THE CMTS MASTER SYMBOL CLOCK FOR THE SHARED UPSTREAM. MAP DOWNSTREAMS TO PARTICULAR OPTICAL NODES AND GENERATE DOWNSTREAM MAPPER SWITCH CONTROL SIGNALS TO IMPLEMENT THIS INITIAL DOWNSTREAM MAPPING. START TRANSMITTING DOCSIS DOWNSTREAMS OF ONE OR MORE TYPES ON EACH OPTICAL NODE

224

DMAC PROCESSES FOR DOWNSTREAMS
SHARING AN UPSTREAM SEND DOWNSTREAM SYNC
MESSAGES WITH TIMESTAMP SAMPLES THEREIN

226

UMAC DECIDES WHICH DOWNSTREAMS ARE TO SHARE AN UPSTREAM, AND CONTROLS SWITCH 12 TO SEND DATA DEFINING SHARED UPSTREAM CHANNEL PARAMETERS AND BURST PROFILE FOR THE SHARED UPSTREAM TO DMAC PROCESS FOR EACH DOWNSTREAM WHICH IS TO SHARE THE UPSTREAM. UMAC FOR SHARED UPSTREAM OR SOME OTHER CONTROL COMPUTER THEN GENERATES SUITABLE CONTOL SIGNALS TO CONTROL UPSTREAM MAPPER TO COUPLE THE UPSTREAM SIGNAL PATHS FROM OPTICAL NODES WHICH RECEIVE DOWNSTREAMS SHARING THE UPSTREAM TO THE RF INPUT OF THE SHARED UPSTREAM RECEIVER TO IMPLEMENT THE INITIAL UPSTREAM MAPPING

228

DMAC PROCESSES USE DATA RECEIVED FROM UMAC PROCESS FOR SHARED UPSTREAM TO GENERATE AND TRANSMIT UCD MESSAGE DEFINING THE CHANNEL CHARACTERISTICS AND BURST PROFILE OF SHARED UPSTREAM

230

UMAC PROCESS FOR THE SHARED UPSTREAM DETERMINES INITIAL RANGING CONTENTION INTERVALS AND TRANSMITS MAP DATA TO APPROPRIATE DMAC PROCESSES OF DOWNSTREAMS THAT WILL SHARE THE UPSTREAM (THE DMAC GROUP)

TO FIG. 11B

FIG. 11A

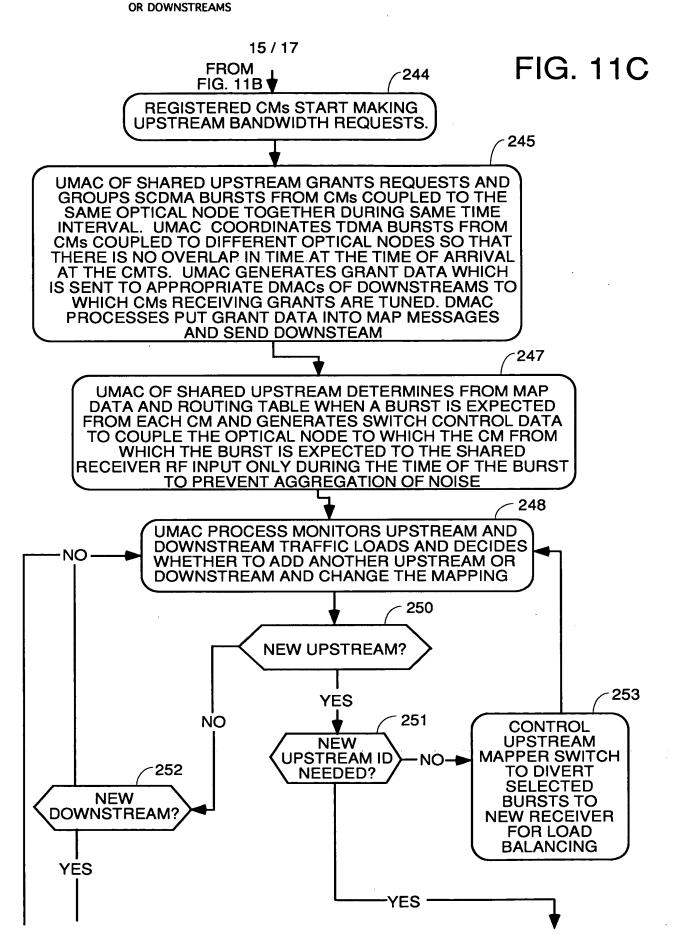
14/17 FROM 232 FIG. 11A ♥ DMAC GROUP PROCESSES DATA DEFINING INITIAL RANGING CONTENTION INTERVAL INTO MAP MESSAGES AND SEND MAP MESSAGES ON ALL DOWNSTREAMS THAT SHARE THE UPSTREAM -234 UMAC OF SHARED UPSTREAM AND SHARED RECEIVER RECEIVES UPSTREAM RANGING BURSTS FROM CMs TUNED TO DOWNSTREAMS IN THE DOWNSTREAM GROUP AND PROCESSES THEM IN CONVENTIONAL DOCSIS RANGING TO MAKE OFFSET MEASUREMENTS AND DEVELOP UPSTREAM EQUALIZATION COEFFICIENTS AND SENDS RANGING RESPONSE MESSAGE TO EACH CM FROM WHICH A RANGING BURST WAS SUCESSFULLY RECEIVED. 236 UMAC OF SHARED UPSTREAM DOES DISCOVERY OF WHICH CMs ARE TUNED TO THE DOWNSTREAMS IN THE DOWNSTREAM GROUP USING THE DOWNSTREAM IDs AND SIDs AND/OR MAC ADDRESSES IN THE INITIAL RANGING BURSTS. UMAC BUILDS A ROUTING TABLE FROM THIS INFORMATION. 238 UMAC OF SHARED UPSTREAM DETERMINES WHICH CMs STILL NEED TO SEND MORE RANGING BURSTS TO ACHIEVE INITIAL SYNCHRONIZATION AND GENERATES MAP DATA SETTING A PERIODIC STATION MAINTENANCE INTERVAL FOR EACH SAID CM. MAP DATA IS SENT TO DMAC PROCESSES FOR THE DOWNSTREAMS TO WHICH THESE CMs ARE TUNED. 240 CONVENTIONAL DOCSIS RANGING PROCESS IS COMPLETED USING INVITED RANGING BURSTS AND CMs REGISTER WITH CMTS. - 242 OPTIONAL: UMAC PROCESS MONITORS SIGNAL-TO-NOISE RATIO, RECEIVED SIGNAL POWER, BIT ERROR RATE, BYTE ERROR RATE, PACKET LOSS RATE, AND IF UNACCEPTABLE, CREATES A NEW LOWER THROUGHPUT UPSTREAM AND ASSIGNS CMs THAT ARE HAVING PROBLEMS TO THAT NEW UPSTREAM. 'TO FIG. 11C FIG. 11B

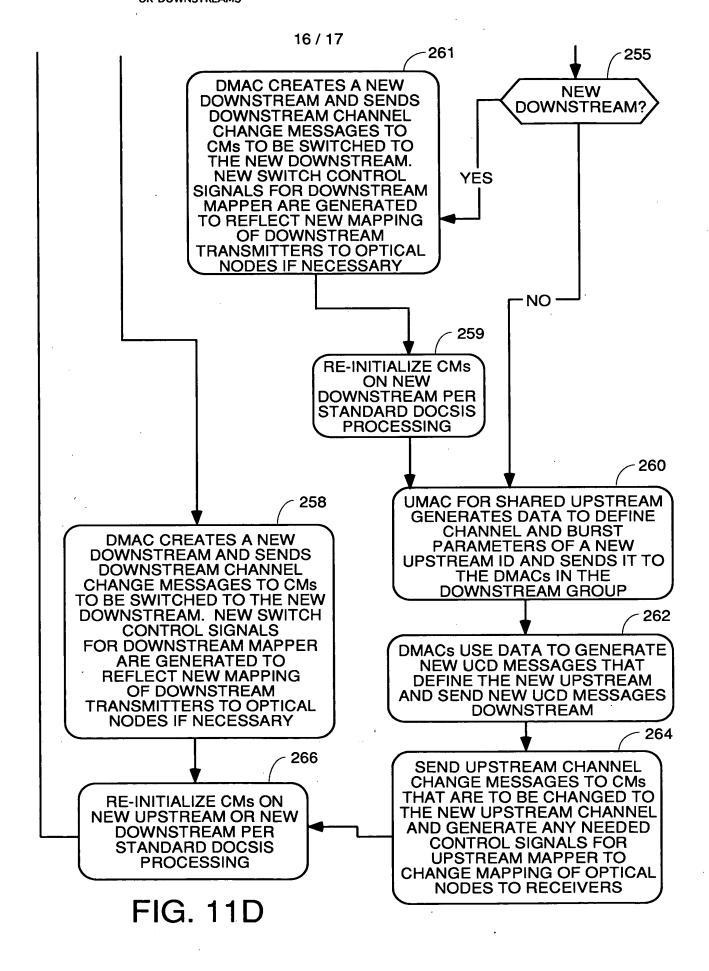
Inventor: RAKIB, et al.

CABLE MODEM TERMINATION SYSTEM WITH FLEXIBLE ADDITION OF SINGLE UPSTREAMS

Docket No.: TER-045

Application No.: 10/725,092





Title: CABLE MODEM TERMINATION SYSTEM WITH FLEXIBLE ADDITION OF SINGLE UPSTREAMS OR DOWNSTREAMS

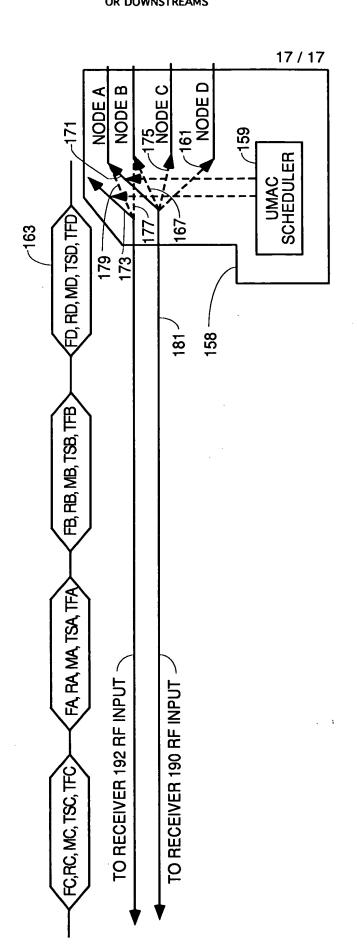


FIG. 12